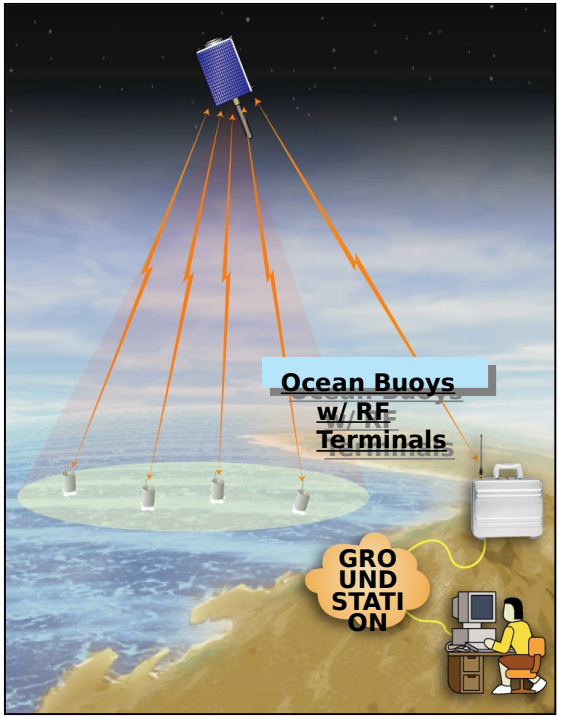
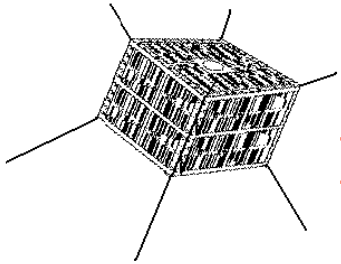
USNA-0601
ParkinsonSAT Remote Data Relay (Psat)

Navy Space Experiments Review Board (SERB)
July 2006



ODTML



Psat

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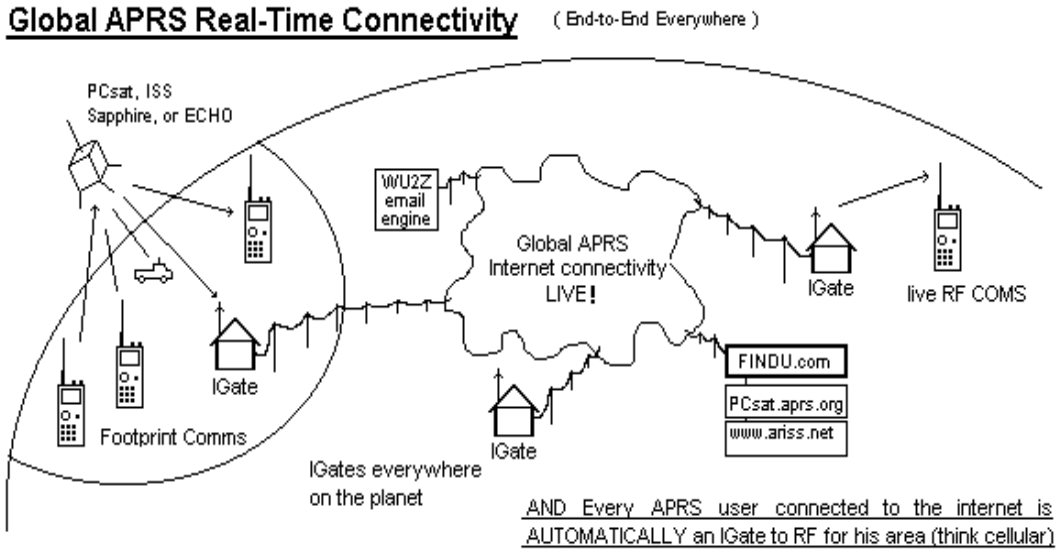
Sponsor: ONR , Aerospace Corp

UNCLASS

Psat (USNA-0601)
Experiment Concept

Objective: Remote Data Relay Transponder for low cost Sensors, Vehicles and Stations



Description:

Educational Spacecraft -

- ODTML UHF transponder
- MIDN Radiation Sensor
- University VHF Remote Data Experiment Transponder
  - Remote Data Relay
  - Global Internet Gateways
  - Open System Tracking
  - Draw from 30,000 users
  - Scaleability and Constellation
  - 9 dB link advantage to UHF

Previous Priority:

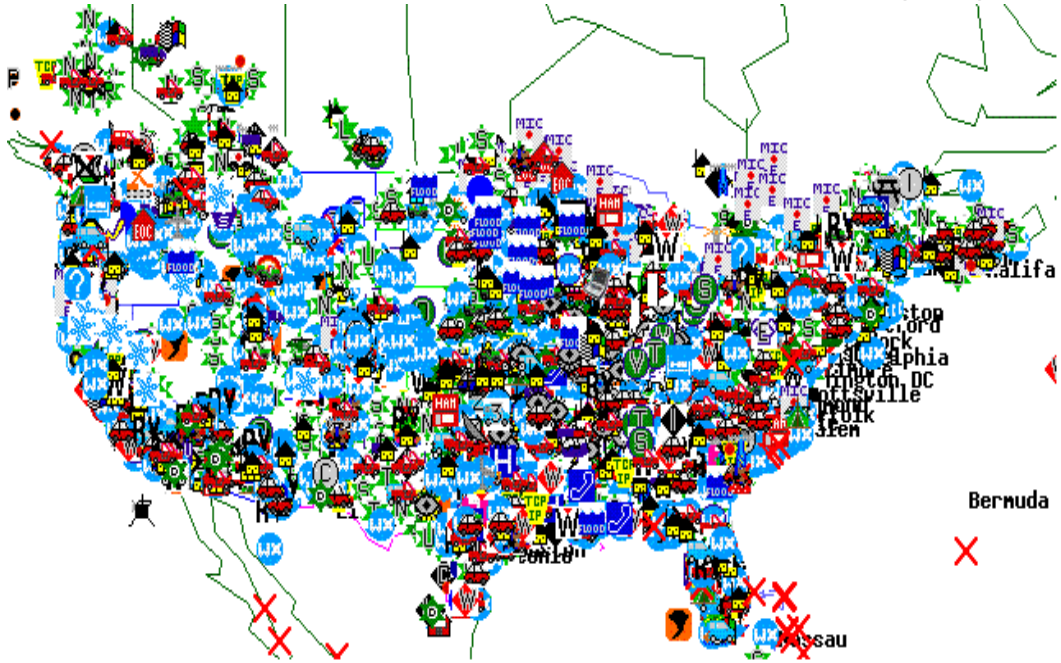
- New Start 2006
- Can fulfill some of SCIENCE objectives

Complementary Experiments:

- Transparent protocol. Can support any AX.25 device
- Off the shelf $250 systems exist. 30,000 users
- Compatible with PCSATs, ANDE, RAFT, ARISS, ECHO, etc

P-SAT (USNA-0601) Intro and Background

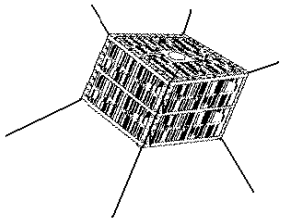
- Psat is to be a low cost educational transponder supporting not only ODTML, but also a University Remote Experimental Data Relay system.

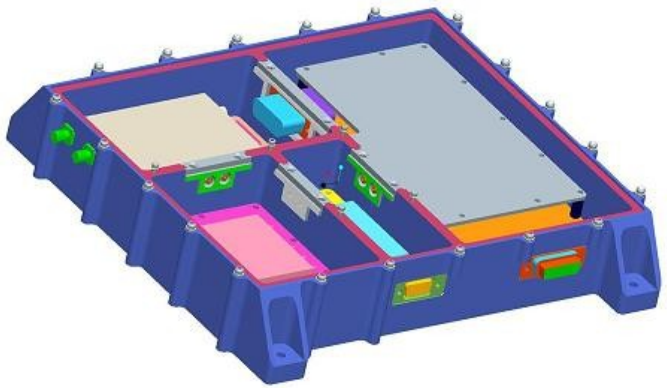


- The University channel can potentially draw from over 30,000 experimenters for easy assessment of loading and

- Not only the sensors and users exist, but the global Internet collection and distribution system also exists from PCSAT1 & 2.

Psat (USNA-0601) Technology & Development





Major Instrument or Equipment:

- ODTML UHF Data Transponder
- Psat University VHF/UHF Data Transponder
- PCSAT-1 style Open Educational Force Tracking
- MIDN Radiation Sensor

Instrument or Equipment Operation:

- Dual Redundant C&DH and quad payload receivers
- TDMA channel sharing 1200/9600 baud
- Aloha, Slotted Aloha, and CSMA
- Additional Voice Relay and file store/forward
- Sun pointing for lower cost solar power system
- Low cost attitude control +/- 40 degree requireme

Experiment Funding:

Prior	FY06	FY07	FY08
0	10k	20k	20k
0	10k	20k	20k

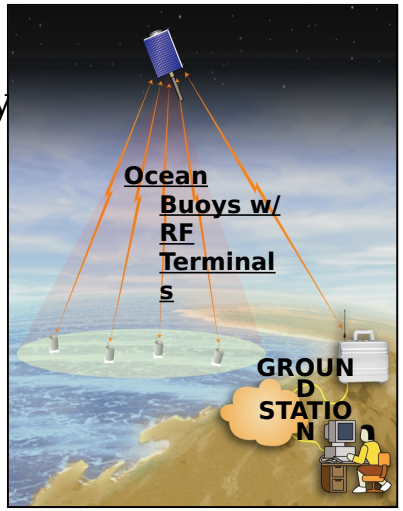
Hardware Status:

- All Technologies are mature and off the shelf
- All technologies have space heritage (PCSAT)
- CDR: Spring 2007
- Flight Ready: Spring 2008

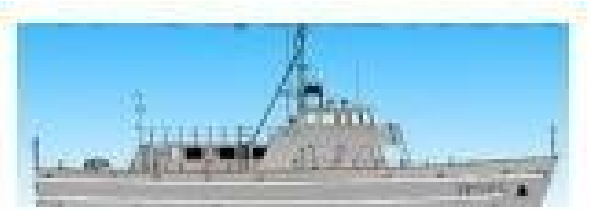
Psat (USNA-0601) Military Relevance

Military Needs:

- ODTML Force Multiplier. Easy testing of Large Scaleability
- Data Exfiltration and service to low power/low-priority users
- Education and experience for Future Naval Officers & Space Cadre
  - DOD Schools: **Service Academies (4)**
    Graduate Institutions (3)
    ROTC Units (550 Schools)
  - DOD Comms Cadre: **Civil Air Patrol (1800 units)**
    Military Affiliate Radio Stations (8000)
    US Coast Guard Auxiliaries (33,000)



Documentation:
- NDAA (P.L. 104-201) Directs ...Ocean Research and Sciences
- CNA study (June 04) identifies data exfiltration requirement
- USSpaceCom Long Range Plan, p77-79 - education

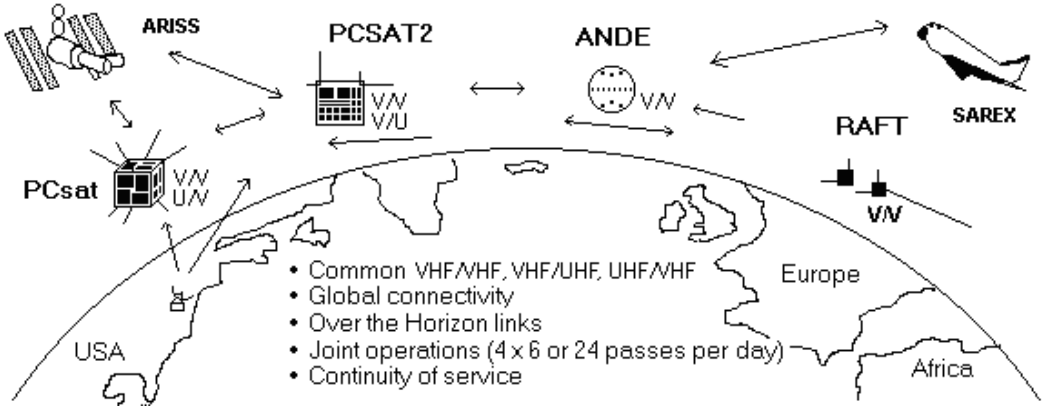


The Yard Patrol Craft

Psat (USNA-0601) Flight Requirements

Need for Spaceflight

- Remote Data Relay requires Communications orbit.
- Data Sources, Data Users are distributed worldwide
- Force Multiplier for ODTML constellation



Experiment / Flight Data:

- Apogee: 500 to 1500 km
- Perigee: 500 to 1500 km
- Inclination: 20 to 98 deg (lower, if higher)
- Physical Data: .02 m^3, 20 kg, nominal 20 W
- Shuttle/ISS Required: [No]: Acceptable: [No]
- Experiment Retrieval Required: [No]
- Repetitive/incremental step flights: [No]

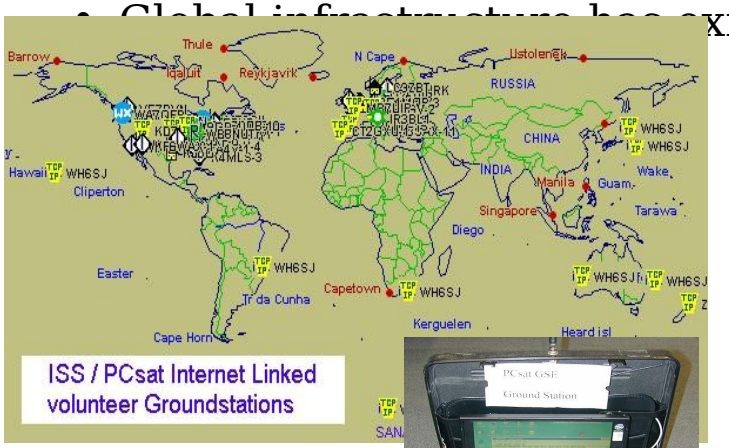
Requested STP Services

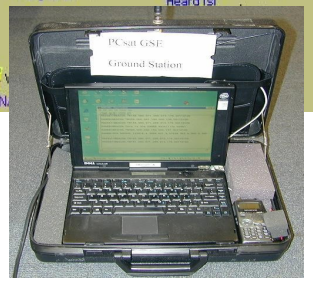
- Launch Services
- Launch Integration

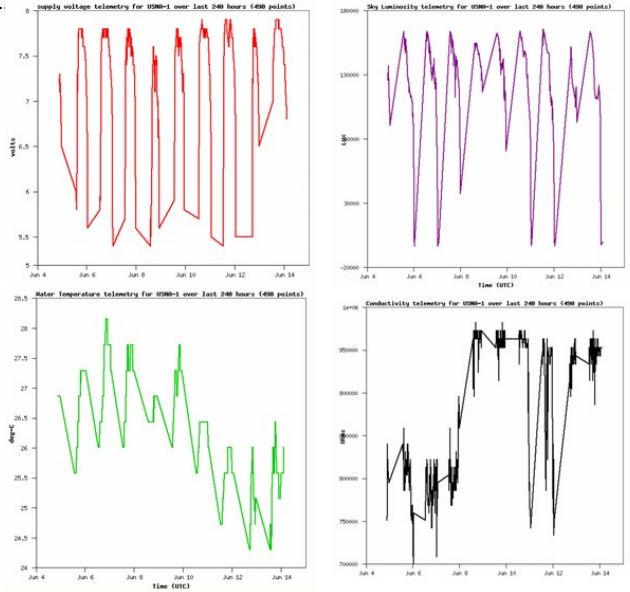
Psat (USNA-0601)
Technology Transition/Data Application Plan

Transition Plan

- All data from all experiments available live via Internet feeds from global ground stations
- All AX.25 Data and formats handled transparently by Satellite and Global Infrastructure
- New-User, New Experiment, New Data transparently accomodated instantly.
- Global infrastructure has existing WEB telemetry displays built in

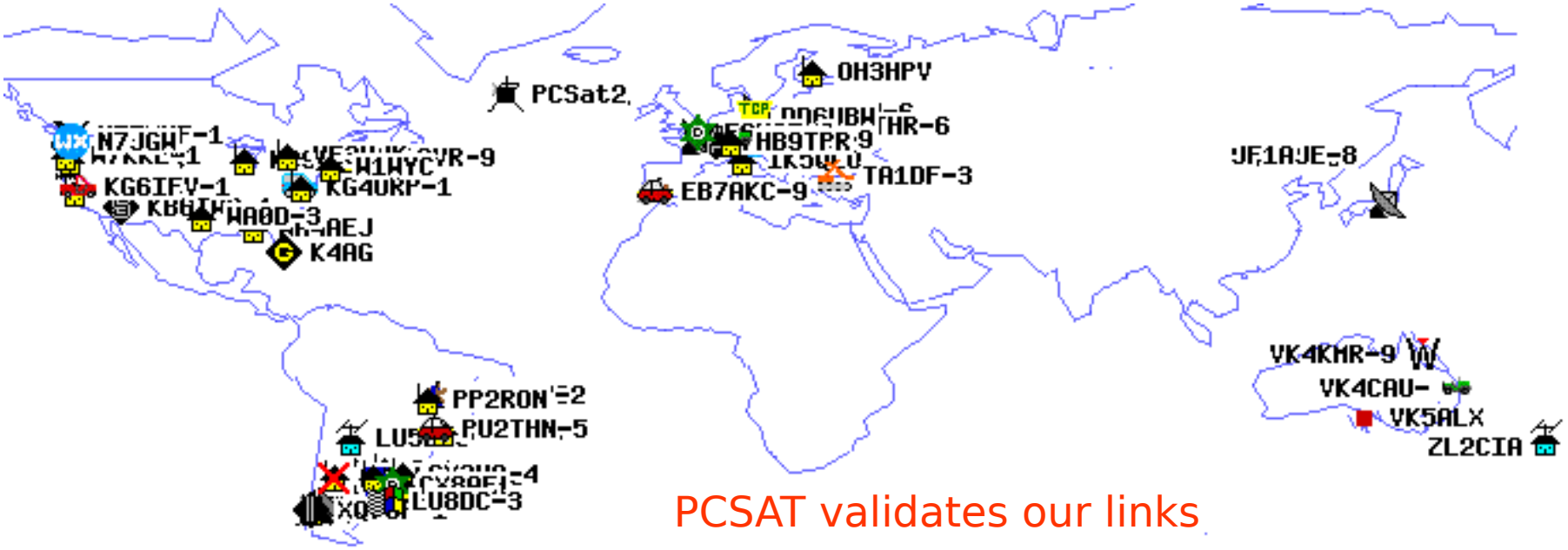




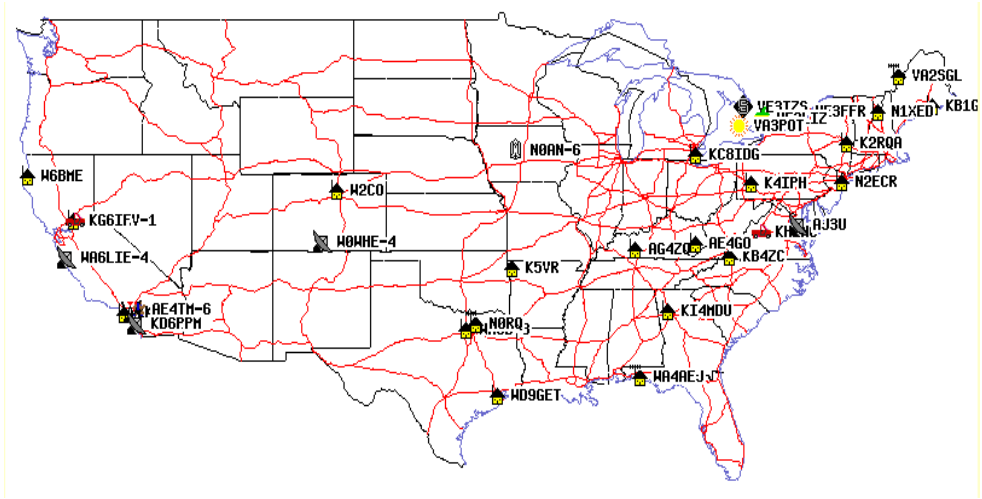


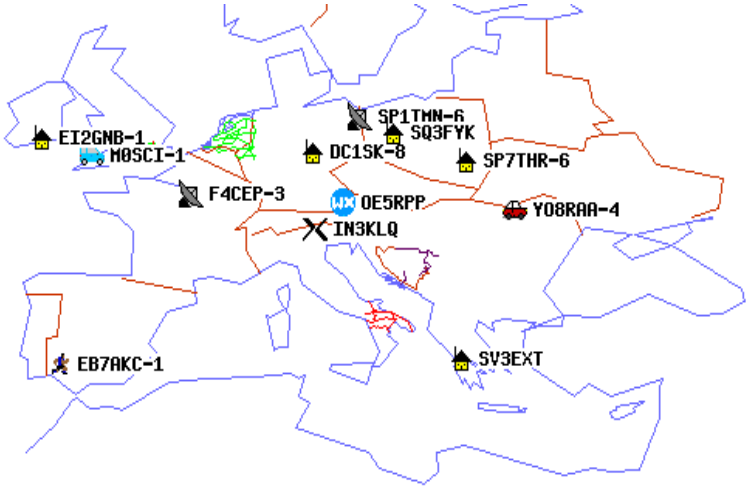
Sensor Buoy Baseline

PCSAT2 User Plot 18 Apr 06



PCSAT validates our links





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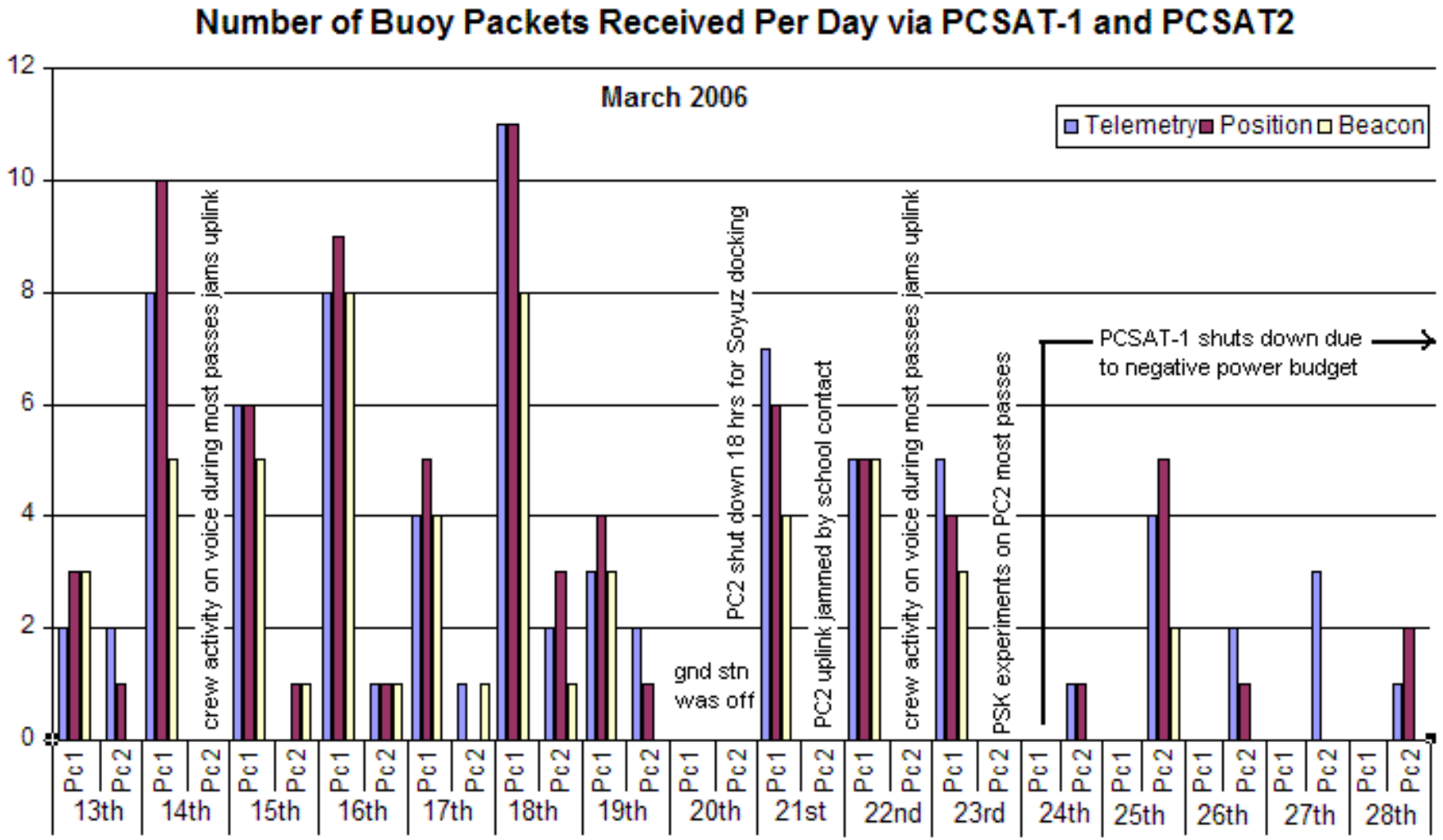
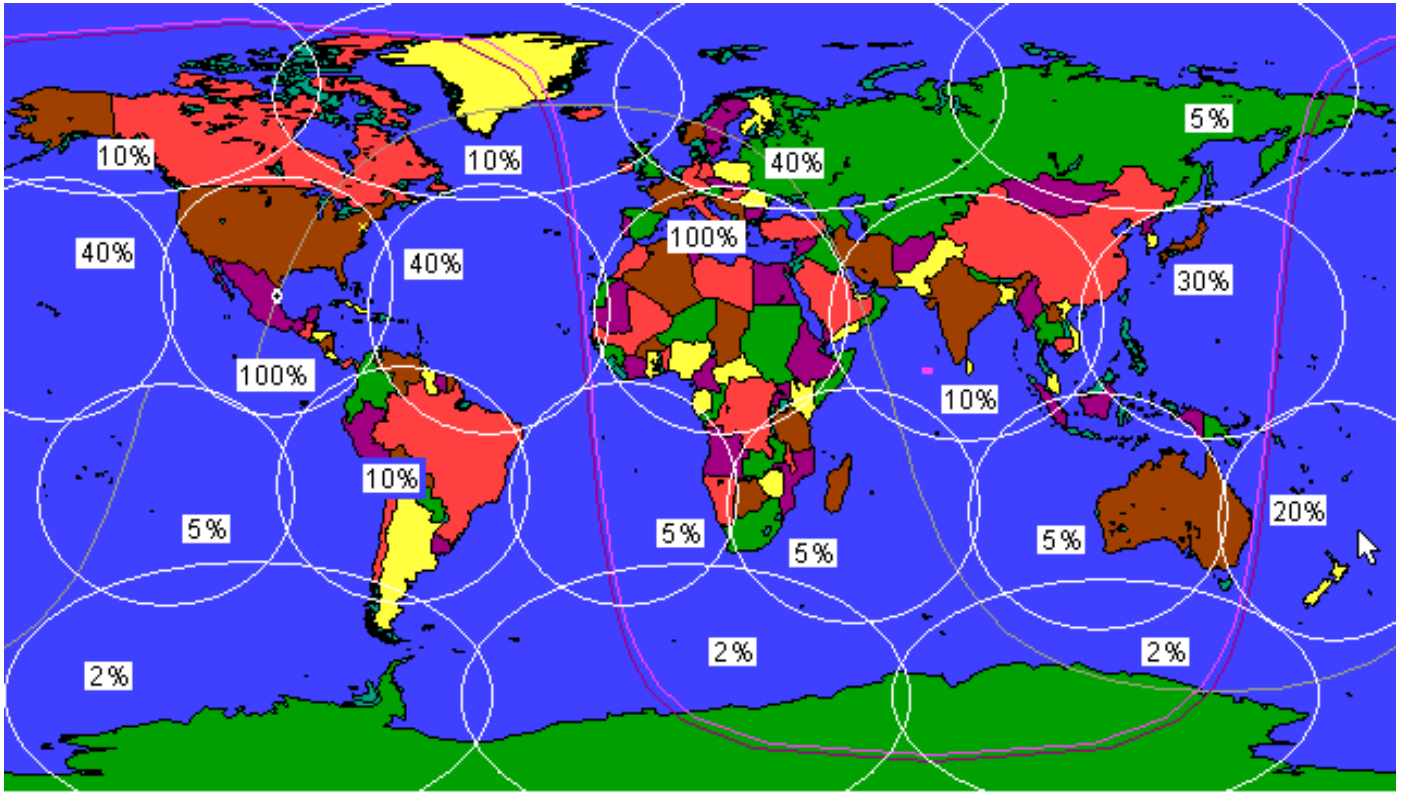


Mission Scale – Buoy Demographics



Global coverage for 3000 km radius footprints. One footprint is about 5% of area. .
Overall global average dutycycle is about 20%.

Theoretical capacity: 2880

144/5%

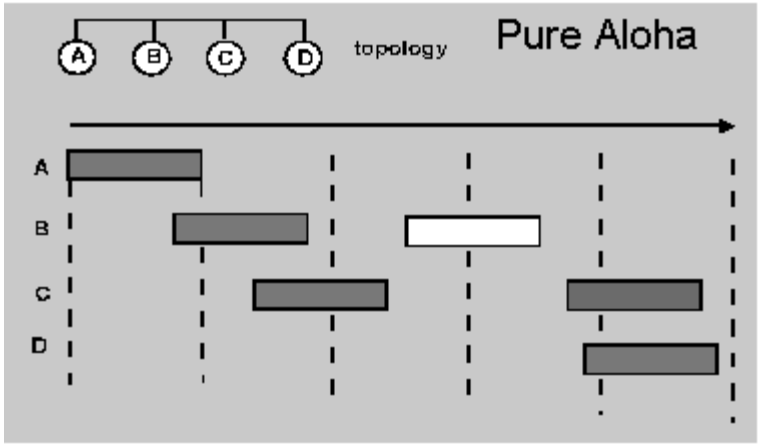
Expected capacity: 720

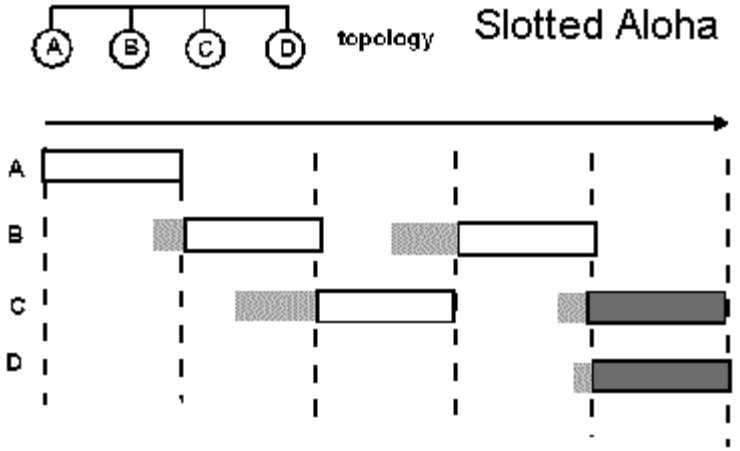
144/20%

Lovick

Mission Scale - Channel Capacity

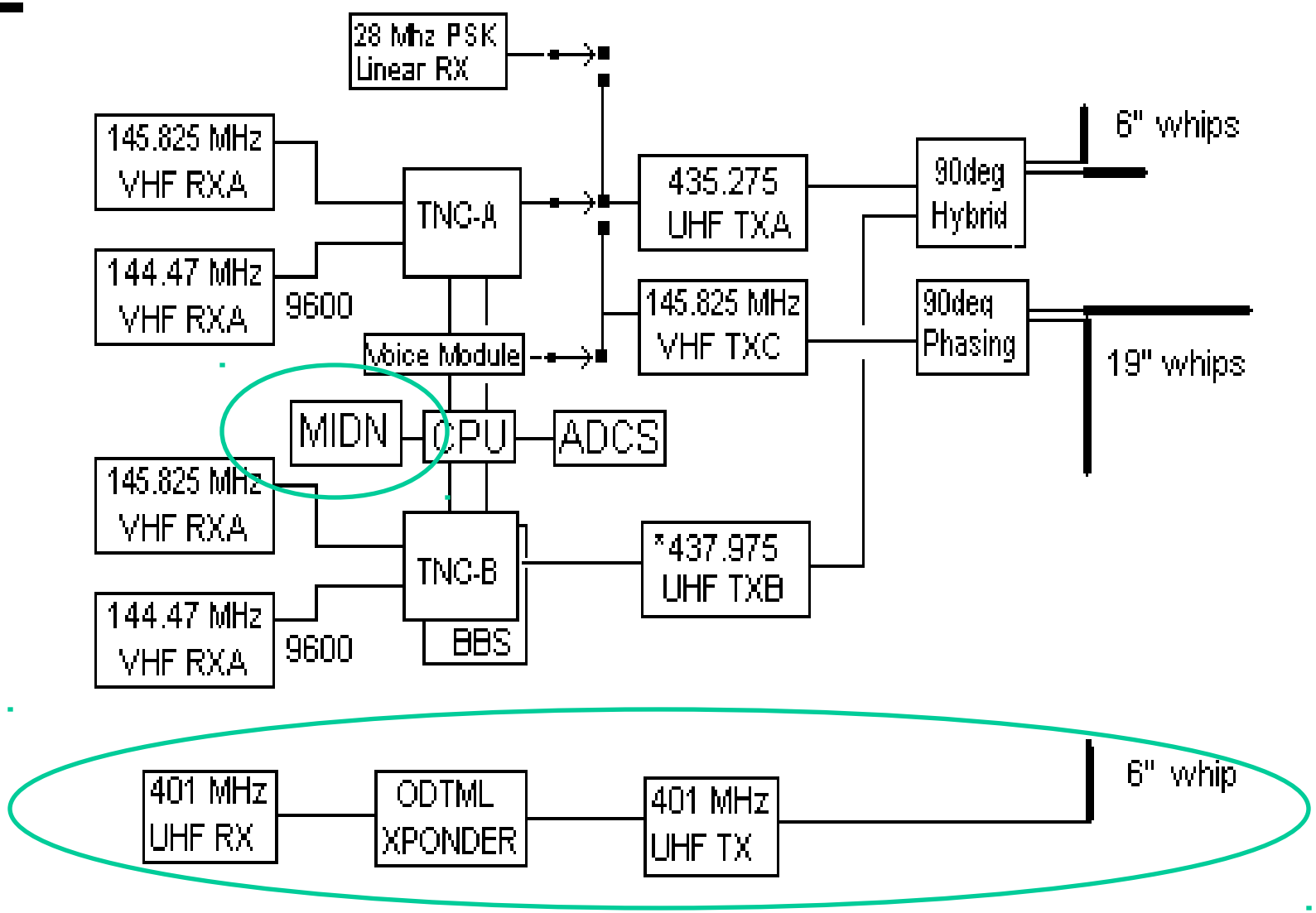
- Time Division Multiple Access (TDMA)
  - Pure ALOHA 18% channel capacity
  - CSMA ALOHA 36% channel capacity (not via sat)
  - Slotted ALOHA 36% (uses GPS timing)





Lovick

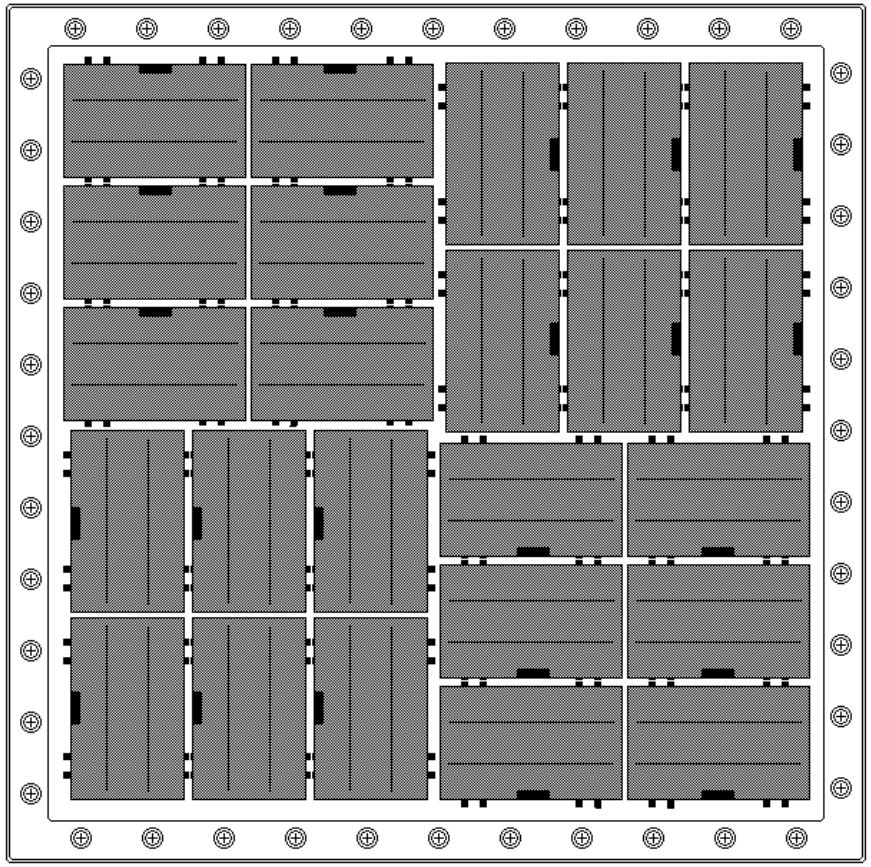
ParkinsonSAT Functional Block Diagram



Full System Design

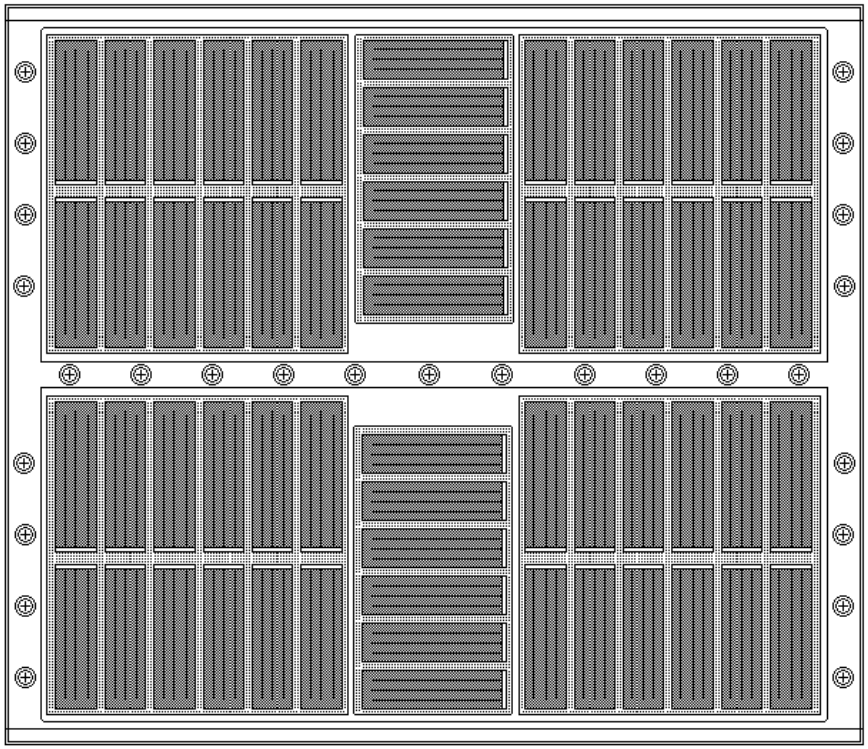
12" Full Size (maximum) Option

18 Watt $ 9,000



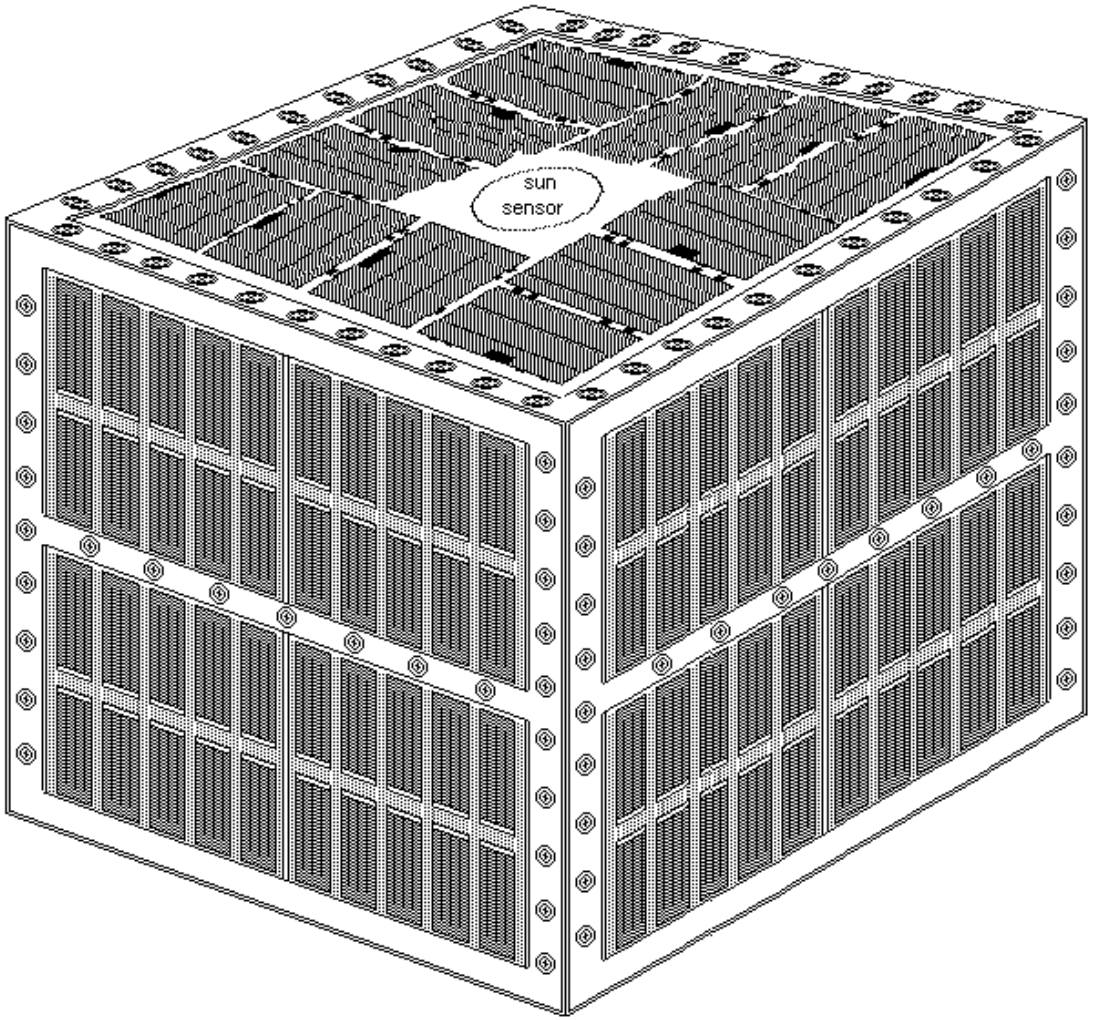
12" Side Panel

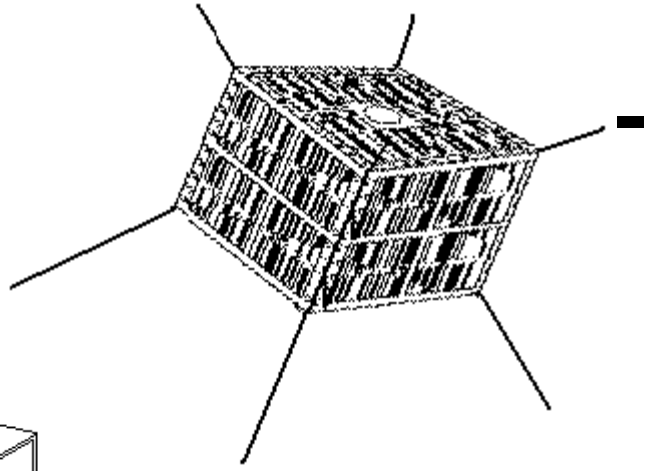
8.4 volts, 900 mA, 7.5 Watts



ParkinsonSAT

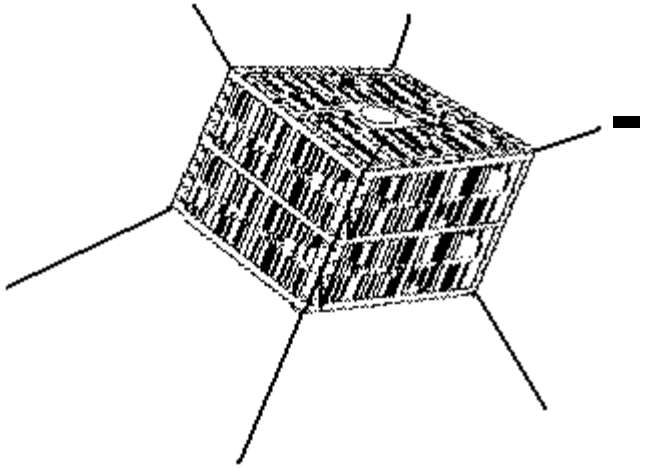
Sun Pointing Design



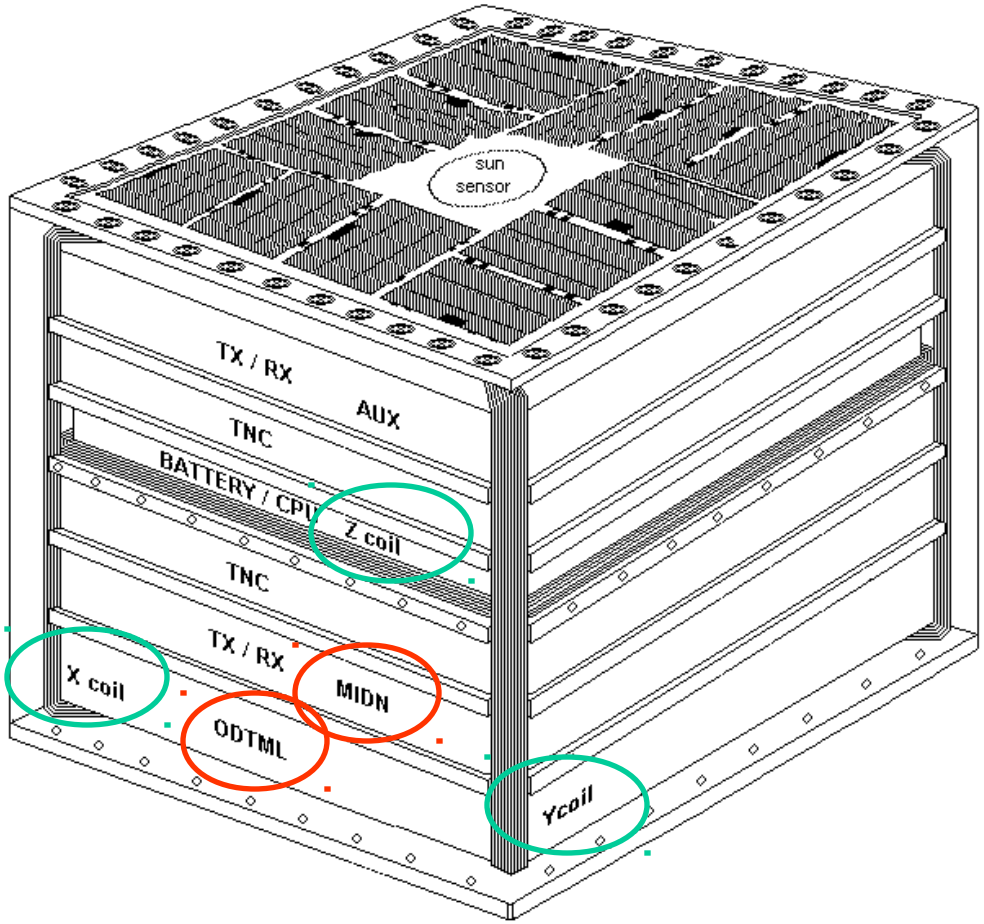


- Full capacity mission transponders
- ODTML Transponder
- MIDN Payload
- ADCS advantage

ParkinsonSAT



Internal Stack



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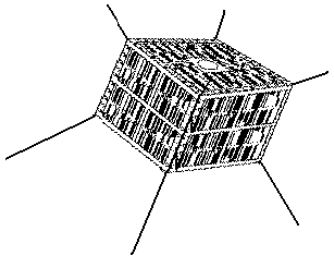
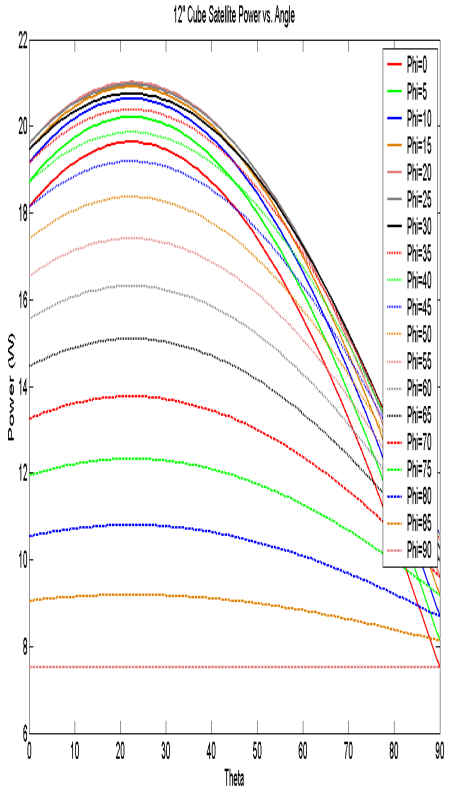
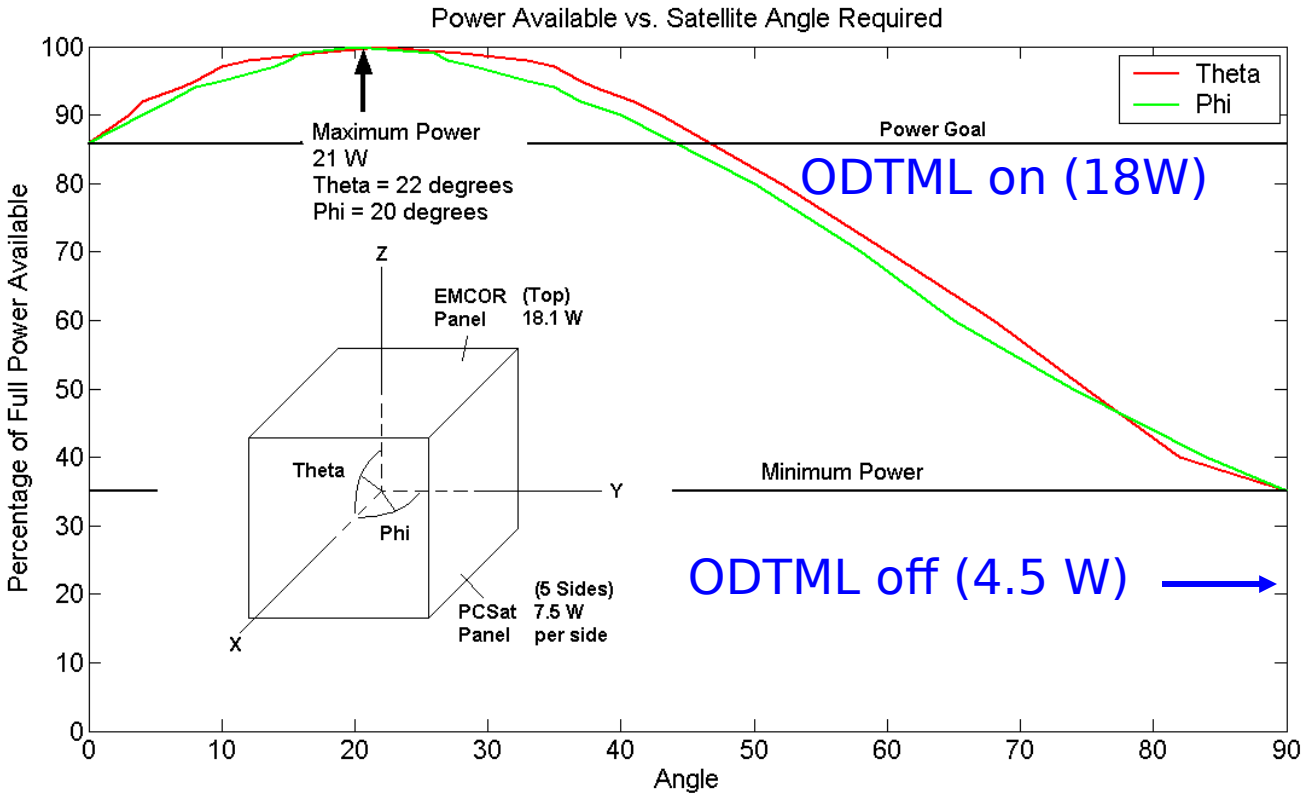
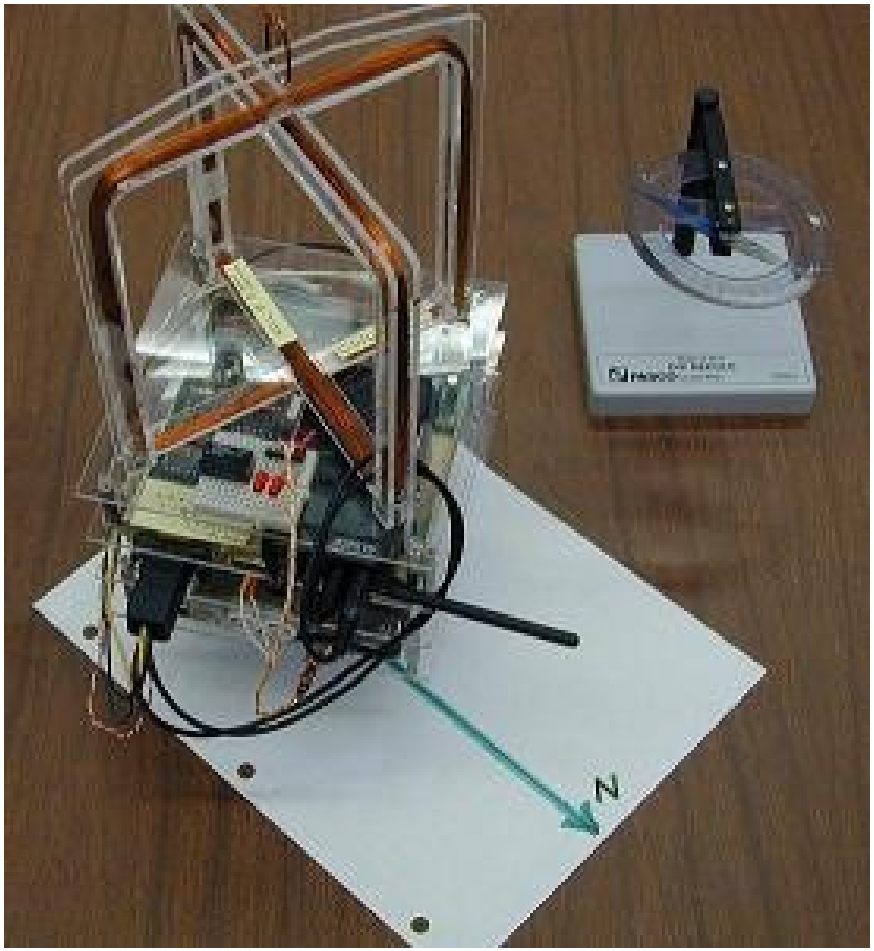


- ✓ Pointing requirements are relaxed +/- 40 deg
- ✓ High precision vector math not required





Magnetic Torque Coils



Torque Lab Experiment

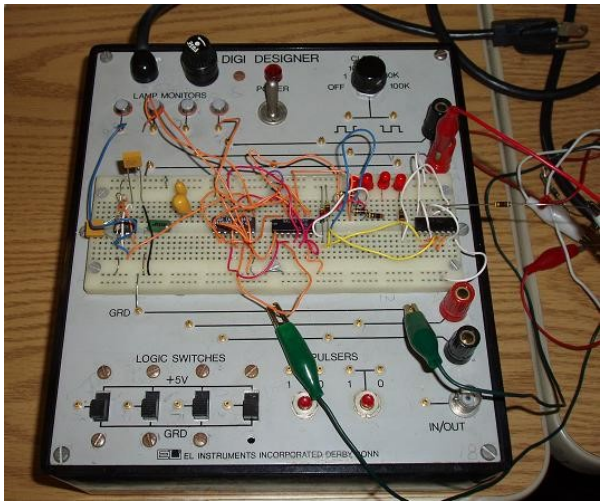
- 200 turns #30
- 42 Ohms, 200 mA
- 1.3 Amp * M^2
- 1.4 kg
- Results in 5 deg / sec

Suggests for ParkinsonSAT

- 200 turns #30
- 4 Amp * M^2
- 14 kg
- Results in 1.5 deg / sec

Using 10% dutycycle pulsing still gives 10 dB margin

Sensor Buoy Baseline



Naval Academy Student Project

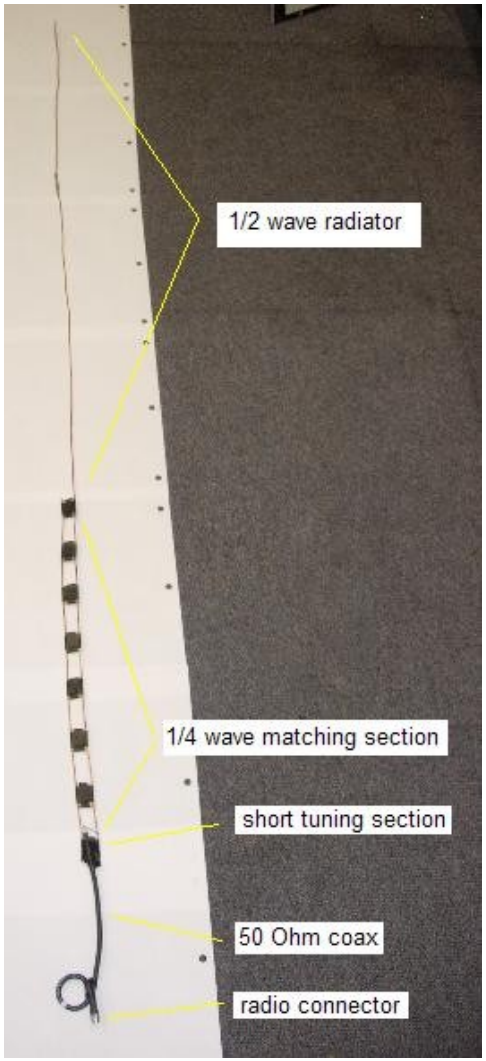
* If free-floating, do not disturb.
* If aground, move to deep water and advise bruninga@usna.edu
* If later than 30 Nov 2006, recover and advise above.

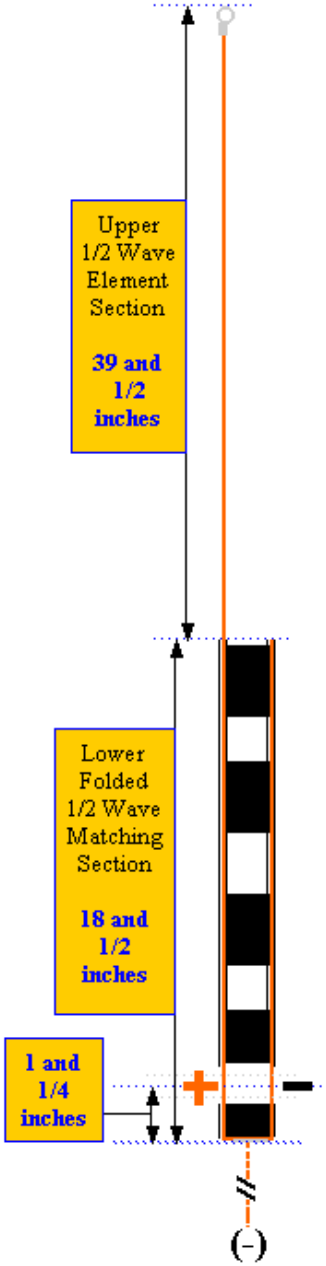
See Buoy Location and Telemetry at

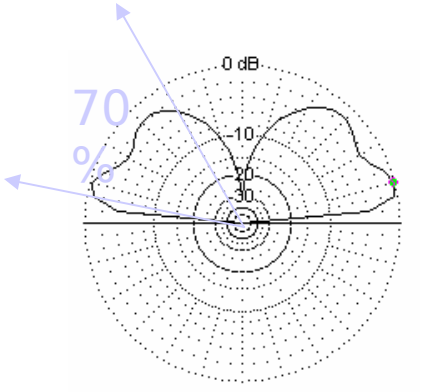
http://www.ew.unsa.edu/~bruninga/buoy.html

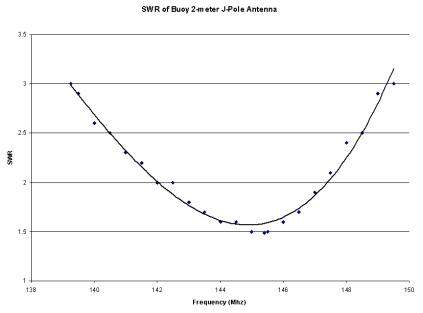
Piggrem

Buoy Antenna Design

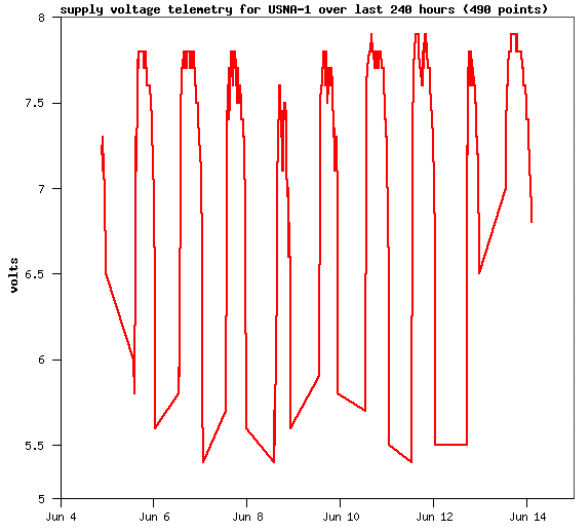


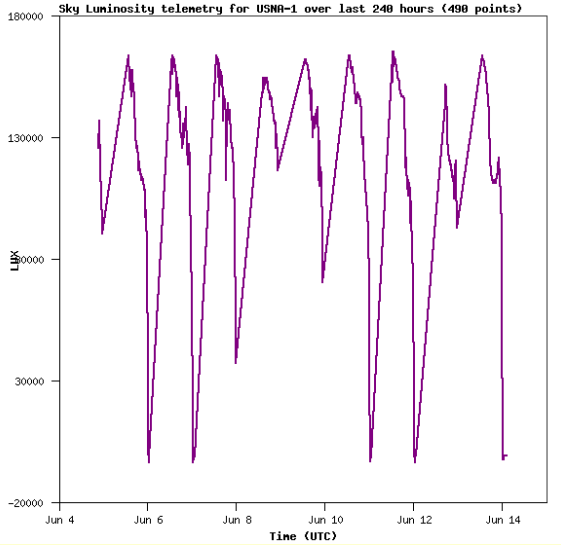


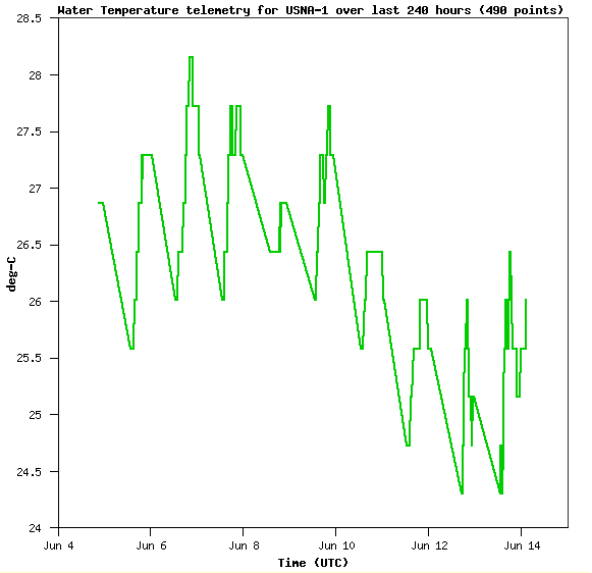


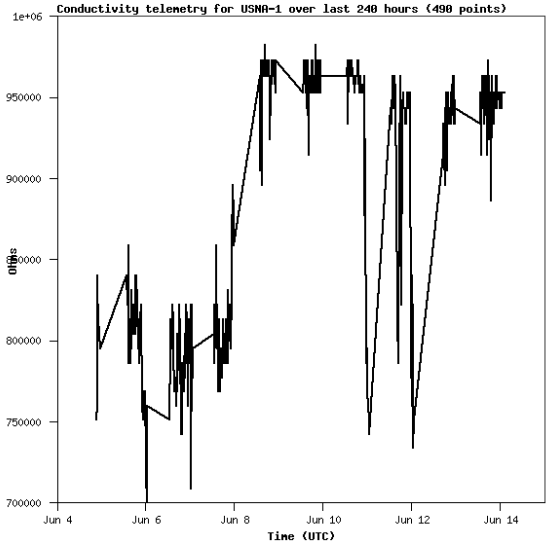


Prototype Buoy Data









Questions
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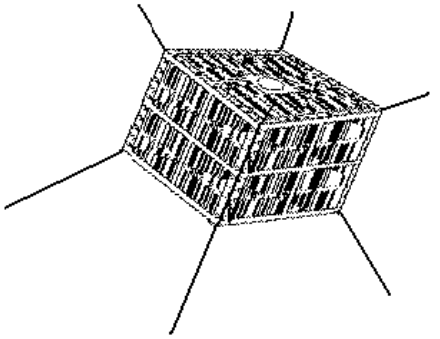
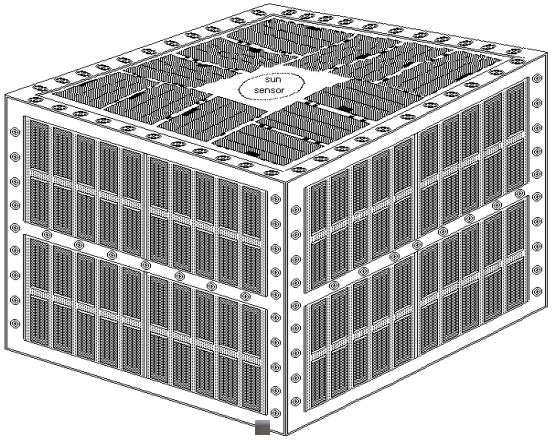
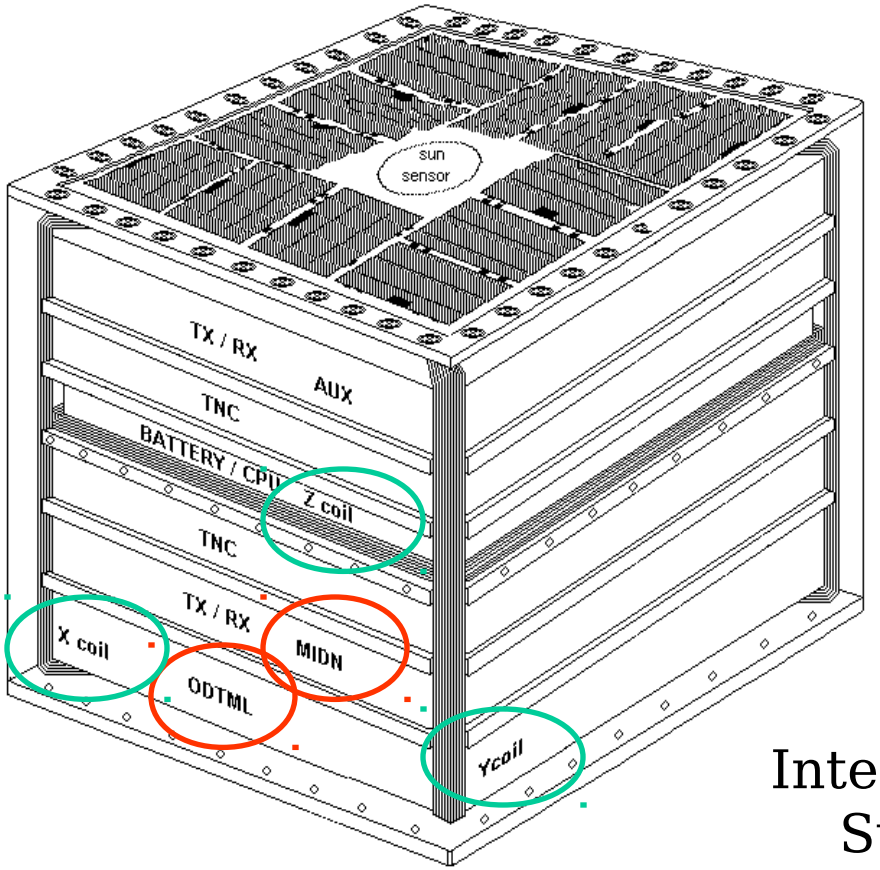




ParkinsonSAT



Internal
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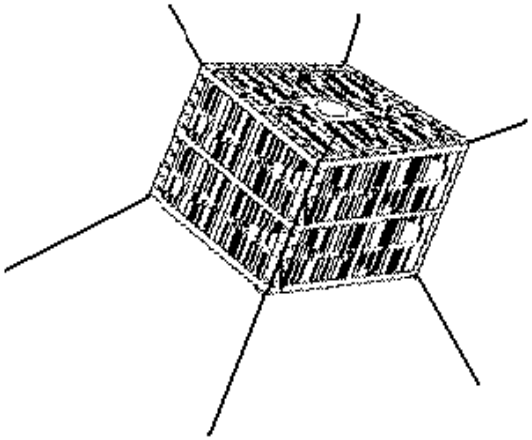

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